Title: Malnutrition and associated factors in elderly hospital patients: a Belgian cross-sectional, multi-centre study.

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Short title: Belgian cross-sectional, multicentre study of malnutrition among elderly

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Abstract

Background & Aims: In Belgium, general data on the prevalence of malnutrition are lacking. Prevalence rates are necessary to gain insight into the magnitude of malnutrition and to establish a nutrition policy that takes the limited health care resources into account. This study aimed to obtain insight into the prevalence of malnutrition in Belgian elderly hospital wards and to identify factors associated with the malnutrition prevalence.

Methods: A cross-sectional, multi-centre study in elderly wards of Belgian hospitals. The nutritional status was assessed using the Mini Nutritional Assessment. A standardised questionnaire was used to record demographic data and data on potential factors associated with malnutrition.

Results: Out of 2329 elderly patients, 33% suffered from malnutrition. Almost 43% of the patients were at risk of malnutrition and 24% were well-nourished. Having swallowing difficulties, taste difficulties, and being transferred from a nursing home were strongly associated with being malnourished.

Conclusion: The malnutrition prevalence in Belgian elderly hospitals wards is similar to international figures. Elderly who have swallowing difficulties, taste difficulties, or coming from a nursing home may need adequate nutritional care. Given the negative impact of malnutrition on mortality and morbidity, an emphasis should be placed on an effective nutritional policy.

Keywords

Malnutrition, Prevalence, Elderly, Hospital, Mini Nutritional Assessment

Introduction

In recent years we are increasingly faced with obesity in our Western society. This health problem receives much attention. Conversely, malnutrition receives less attention, although it is a frequently occurring health problem.

In the current study we focus on malnutrition in the elderly and use the definition of malnutrition developed by Chen, Schelling & Lyder (2001): "*Faulty or inadequate nutritional status; undernourishment characterized by insufficient dietary intake, poor appetite, muscle wasting and weight loss".*[1]

Malnutrition has a detrimental effect on physical and mental health which may lead to a prolonged hospital stay and increased costs for patient and society [2;3]. In Belgium, the total health care expenditure as a proportion of gross domestic product (GDP) was 9.3% in 2004 which is above the European average[4]. The growth in health expenditure in Belgium is comparable to that in other Western European countries and can be explained by several factors, such as the increasing number of elderly people, higher expectations, growth in real GDP and increasing implementation of new technology in the health care sector. Belgium had the fifth highest health care expenditure per capita measured in purchasing power parity among European countries. It is only higher in Luxembourg, the Netherlands, Germany and France. Public sector funding as percentage of total expenditure on health care fluctuates around 70% in Belgium and is expected to rise. One of the challenges for the future Belgian health system is how to improve efficiency of the health system [4]. The Belgian government started with a National Food and Health Plan (NVGP-B) to increase the health status of the population [5].

For the above-mentioned reasons, it is essential to invest in the prevention of malnutrition. Screening for malnutrition is an essential measure in the prevention of malnutrition.

Internationally, the prevalence of malnutrition varies between 13 and 78% [3]. Recently, in a few Western European countries nationwide prevalence studies have been conducted in hospitals [6;7]. The overall prevalence rate of malnutrition was estimated at 23.8% in the Netherlands (n=8028) and at 27.4% in Germany (n=1886). These studies reported prevalence rates in hospitalised elderly patients ranging from 32.9% to 56.2%. Differences in methodology, definition of malnutrition, patient characteristics, and setting among these studies may partially explain the wide range of these figures.

Prevalence rates provide insight into the magnitude of the problem and help to establish a nutrition policy that takes the limited health care resources into account. General data on the prevalence of malnutrition in Belgium are lacking. These data will round out the insight in malnutrition in Western Europe. Belgium is likely to be representative for Western Europe as it located centrally in between the northern and southern part of Western Europe.

The aim of this study was to obtain insight into the prevalence of malnutrition in Belgian elderly hospital wards and to identify factors associated with the prevalence of malnutrition.

Materials and Methods

Setting and sample

The sample for this cross-sectional, multi-centre study consisted of elderly patients from Belgian hospitals. All general and teaching hospitals with elderly wards in Belgium were invited to participate in this study. The participation was completely voluntarily. The participating centres did not receive any financial compensation.
An elderly ward was defined as “an acute hospital ward which provides medical geriatric diagnosis, treatment and revalidation and assures nursing and caring for the elderly patients in the most excellent conditions” (Royal Decree 23-10-1964 and modified by decree 12-04-1984 Art. 1). In Belgium, there are 111 hospitals with geriatric beds.

Patients were included in the study if they were 75 years or older and gave informed consent to participate in the study.

Instruments

To evaluate the nutritional status of the elderly, the short form of the Mini Nutritional Assessment (MNA-SF) was used. The MNA is extensively validated and provides a most comprehensive insight in the nutritional status of the elderly patient [8-11]. This instrument is recommended by the European Society of Parenteral and Enteral Nutrition (ESPEN) for the detection of the presence of malnutrition and the risk of developing malnutrition among the elderly in hospitals, nursing homes and home-care programmes [8]. The Belgian Health Authorities recommend to use the MNA for elderly patients.[12]

The MNA contains 18 items which are divided into four categories: anthropometric assessment, general assessment, dietary assessment, and subjective assessment. However, as the completion of the full MNA tool is considered to be too time-consuming in geriatric screening situations, MNA-SF was developed [13]. The MNA-SF is highly correlated with the full MNA [13;14]. The MNA-SF consists of six items: food intake, weight loss, mobility, psychological stress or acute disease, neuropsychological problems and body mass index (BMI).

The maximum score on the MNA-SF amounts to 14. If a patient is identified as at risk for malnutrition by the MNA-SF (score <12), the remaining 12 items of the MNA need to be assessed [8;13].

Patients with an MNA score of <17 are considered as malnourished, patients with a score between 17 and 23.5 are identified as at risk for malnutrition. A score of ≥ 12 on the MNA-SF or ≥24 on the full MNA indicate that the patient is well-nourished.

When it was not possible to measure the weight or length of immobile or bed bound elderly, an estimation was used. To determine their weight, patients were asked to estimate their own weight or the health care professional made a subjective estimation. To determine the estimated length, the formula of Chumlea was used which calculates the length of the patient from his knee height. [15] If the elderly had a cognitive impairment and was not able to answer the questions, a family member or a health care worker who knew the patient best was consulted.

In addition, a standardised questionnaire was developed and used to record demographic data and data on potential factors associated with malnutrition. These factors were selected based on a review of the literature [16;17]. Data were recorded on

pathology, swallowing, chewing, taste, digestion (nausea, vomiting, diarrhoea), pain, and mouth infection.

The content validity of this standardised questionnaire and also of the Dutch and French translation of the MNA were evaluated by a double Delphi-procedure [18]. This Delphi-procedure was performed by an expert panel which consisted of 11 experts in nutrition and/or the elderly. A clinical nurse specialist in nutrition, three head nurses of elderly wards, an infection control nurse, a dietician, two professors of geriatrics, a professor of gastroenterology, a gastroenterologist, and a lecturer in elderly care participated in the expert panel. Four were French-speaking and seven Dutch-speaking. The experts reached consensus after the second Delphi-round.

The software package TeleForm, version 10.1 (Cardiff Software, UK) was used to develop the questionnaires.

Data collection procedure

In each participating ward one supervisor was assigned. These supervisors were nurses, dieticians, or other health care professionals. Before the start of study, the research team informed all supervisors and trained them to perform the survey. The main purpose of this training was to ensure the correctness and uniformity of the use of the MNA and the standardised questionnaire. For this purpose, patient cases were used. Each supervisor obtained an information guide on both data collection instruments. This guide supported the supervisors in instructing their colleagues who assisted them with the data collection. All data were registered by a health care

professional. For practical reasons, the participating wards were allowed to choose one day between May 16th and June 15th 2007 to perform the survey.

Ethical consideration

The study procedure was approved by the ethics committee (No B67020071952) of the Ghent University Hospital and of each participating hospital. The aim of the study was explained verbally to each patient. Written informed consent was obtained from all patients. If the patient was unable to give consent, a relative was asked to give their written informed consent.

Statistical analysis

Descriptive data were presented in frequencies and percentages or means and standard deviations. For the univariate and multivariate analyses the independent variable nutritional status was dichotomised in malnourished versus well-nourished or at risk of malnutrition. Additionally, we did the analyses with nutritional status dichotomised in malnourished or at risk of malnutrition versus well-nourished.
Using univariate binary logistic regression analysis, the odds ratio and related 95% confidence interval for each variable was calculated. To evaluate the independence of the observed associations, the variables with a value $p<0.100$ were simultaneously entered in a multivariate binary logistic regression analysis. Multicollinearity and interaction effects were tested. Multicollinearity was observed between the variables swallowing and chewing. The variable with the highest odds ratio in the univariate analysis (swallowing) was included in the multivariate model. No interaction effects were perceived. In the multivariate analysis a value of $p<0.05$ was considered to indicate statistical significance.

All statistical analyses were performed with the software package SPSS version 15.0 (SPSS, Inc, USA)

Results

Demographic data

Eighty-one percent (n=90) of the hospitals with elderly wards in Belgium participated in the study. Five teaching hospitals and 85 general hospitals took part in the study representing 4834 potential participants. Figure 1 presents the flow chart of the included patients. In total, 2667 patients of 178 elderly wards were screened. The data of 336 patients were incomplete. Only patients with complete MNA-SF data were included in the analysis. In total, 2329 elderly patients were analysed in this study. There were no significant differences between included and excluded patients related to the demographic variables (see Table 1).

The majority of the patients (91.9%) were recruited from general hospitals. Almost 70% (n=1629) of the patients were female. Their mean age was 83.8 years (SD 5.19) and their mean BMI was 24.7 kg/m² (SD 5.20). The most frequently occurring pathologies were dementia (15.7%), diabetes mellitus (11.9%), decompensate heart failure (11.3%) and depression (8.0%) (see Table 2).

Demographic data of the total sample of patients admitted in all elderly wards in Belgium during the study period were provided by the Belgian Federal Public Service Health, Food Chain Safety and Environment. The mean age of the total sample was 82.5 years and 68.2% of the patients were female. The occurrence of most pathologies was similar to that of the study sample: dementia 14.7%, decompensate heart failure 15.3%, and depression 7%. Only the occurrence of diabetes mellitus (24%) was higher in the total sample.

Prevalence of malnutrition

Nutritional assessment based on the MNA revealed that 33% (n=768) of all elderly patients suffered from malnutrition. Almost 43% percent (n=997) of the patients were at risk of malnutrition and 24.2% (n=564) were well-nourished. Table 3 presents the characteristics of patients according to their nutritional status. There was no significant difference in nutritional status between patients admitted to teaching hospitals and patients admitted to general hospitals and between male and female elderly. The mean age, length of hospital stay, BMI, and living in a nursing home were significantly different between the three nutritional categories.

Associated factors

Table 4 shows associations between being malnourished and several patient factors. This univariate analysis demonstrates that being 85 years or older, coming from a nursing home, having chronic obstructive pulmonary disease (COPD), malignant disease (oncology), pneumonia, urinary infection, decompensate heart failure, delirium, dementia, depression, taste difficulty, swallowing difficulty, digestion problem, pain, mouth infection, chewing difficulty, and a longer hospital stay were associated with a significantly higher prevalence of malnutrition.

The same univariate analysis with being malnourished or being at risk for malnutrition as dependent variable was performed. The results of this analysis were very similar. Only decompensate heart failure was no longer a significant associative factor.

To confirm associations found in univariate analysis, a multivariate binary logistical regression analysis was performed (see Table 5). Patients with swallowing difficulties were almost five times more malnourished. Elderly patients coming from a nursing home were almost three times more likely to be malnourished than patients coming

from home or a service flat. Patients with taste difficulties had two and a half times more risk to be malnourished. Patients with digestion problems had approximately 85% more chance of being malnourished and patients who are 85 years or older 35%. Some pathologies (COPD, malignant disease, pneumonia, dementia, major abdominal surgery, depression, and delirium) increased the chance of being malnourished between 42% and 86%. Finally, patients with a longer hospital stay also had a higher risk to be malnourished.

The same multivariate analysis with being malnourished or being at risk for malnutrition as dependent variable was carried out. The results were fairly similar. Major abdominal surgery, decompensate heart failure, and taste difficulty were no longer significant independent factors. On the contrary, urinary incontinence became a significant associated factor.

Discussion

This study was the first Belgian large-scale cross-sectional multi-centre study focusing on malnutrition in elderly patients. Based on the MNA, 33% of the elderly hospital patients were malnourished. This prevalence figure is consistent with recent European prevalence figures in elderly hospital patients [6;7;19]. In the annual national Dutch survey, the prevalence of malnutrition in geriatric hospital wards was similar (32.9%). However, in that study, malnutrition was defined according to one of the following criteria: BMI less than 18.5 kg/m², unintentional weight loss (6 kg in the previous 6 months or 3 kg in the previous month), or BMI between 18.5 and 20 kg/m² in combination with no nutritional intake for 3 days or reduced intake for more than 10 days [6]. In the German study, the prevalence in the geriatric departments was higher. In total, 56.2% of the patients suffered from moderate or severe malnutrition. The subjective global assessment (SGA) and anthropometric measurements were used to assess the nutritional status [7].

In Belgium, malnutrition is a substantial problem in elderly hospital wards. Besides the 33% malnourished elderly, nearly 43% was at risk for malnutrition. Almost four out of five elderly patients were at risk for malnutrition or suffered from malnutrition and only 24% was well-nourished.

As mentioned above, this was the first large-scale study focusing on the prevalence of malnutrition in Belgium. However, there have been some other studies, often small in size, in which the nutritional status of elderly patients in Belgian hospitals was investigated. [20-24] These studies focused, for example, on the prevention of malnutrition, a nutritional care program, a minimum geriatric screening tool to detect geriatric problems including nutrition, and the use of the MNA. In two of these studies the prevalence of malnutrition was explored. [20;23] In the study of Gazzotti et al. [20],

studying the clinical usefulness of the MNA in geriatric medicine, 22% of the hospitalised elderly patients were malnourished and 49% were at risk of malnutrition. This prevalence figure is lower than in our study, however, the sample included only 175 patients. Next, in the study of Pepersack [23], 1139 patients consecutively admitted to 12 geriatric wards were studied concerning the outcomes of a continuous process improvement of a nutritional care program. For this purpose the median score of the MNA was evaluated, however no real prevalence figures of malnutrition were given. The median value on the MNA was 18 points which indicates also a high prevalence of poor nutritional status among hospitalised elderly.

Several independent patient factors were found to be associated with malnutrition or being at risk for developing malnutrition. These identified factors provide valuable information on those patients with a high risk to develop malnutrition and may consequently facilitate the detection of patients with a poor nutritional status.
Three factors were rather strongly associated with being malnourished, namely swallowing difficulties, taste difficulties, and being transferred from a nursing home. Among these factors, having swallowing difficulties had the most powerful relationship with being malnourished.
Both swallowing and taste difficulties are known to be associated with age and disease as well as treatment factors [3]. Patients with swallowing difficulties may have a decreased food intake which makes them more vulnerable for malnutrition. Suominen et al. [19] found also a quite strong association between swallowing difficulties (OR 3.03; 95%CI 2.10-4.37) and malnutrition (MNA <17) in nursing home residents in Helsinki. Furthermore, having taste difficulties was also relatively highly associated with a poor nutritional status. Elderly patients with taste difficulties may

have a poor appetite and consequently an insufficient food intake. In literature, taste difficulties are often cited as a causal factor of malnutrition [3;25]. Next, coming from a nursing home was an important associated factor. In the Belgian study of Gazzotti et al. [20] was also found that patients originating from nursing homes had a poorer nutritional status than those living at home. Elderly coming from a nursing home are generally highly dependent in their functioning. If they need to be admitted to the hospital, their general condition will be poor which might make them more susceptible for malnutrition. On the other hand, these elderly may already have been malnourished in the nursing home as several studies have revealed that elderly residing in nursing homes often suffer from malnutrition [19]. In order to gain insight in the problem of malnutrition in Belgian nursing homes, it would be interesting to perform a prevalence study in this setting.

Various medical conditions such as COPD, pneumonia, and malignant disease may reduce the appetite and have a negative influence on the nutritional intake [26]. Several studies revealed also an association between respiratory diseases and malnutrition. In the Dutch annual prevalence study, also a multivariate logistic regression was performed which indicated that COPD was independently associated with malnutrition (OR 1.58 95% CI 1.40-1.80) [6]. However, as stated above, malnutrition was defined differently than in the current study. Pirlich et al.[7]and Meijers et al. [6,]identified in their nationwide studies, respectively in Germany and the Netherlands, malignant disease as an independent risk factor for malnutrition in hospital patients (Germany: 1.51; 95%CI 1.18-1.93 and the Netherlands: OR 2.74; 95% CI 2.39-3.15). In addition, pathologies such as dementia, depression, and delirium may be associated with a poor appetite. It must be noted that the factors dementia and

depression are included in the MNA. Logically, an association was found between malnutrition and those factors. Several other studies also found an association between malnutrition and depression [27;28] and between malnutrition and dementia [6;19]. Furthermore, abdominal surgery and digestion problems may have a negative impact on the ability to digest and absorb nutrients and thus increase the risk of malnutrition [26]. In the present study, the impact of length of hospital stay on malnutrition was rather low (OR 1.01; 95% CI 1.00-1.01). In several studies a longer hospital stay was correlated with malnutrition {Martins, 2005 39 /id;Pirlich, 2006 32 /id;Van Nes, 2001 8614 /id}. In the study of Meyers et al. [6] no significant association with time since admission was found. The association between age and malnutrition is obvious. Older people are especially vulnerable to malnutrition as they frequently have multiple pathologies and impairments, and poor nutritional intakes [25].

Similar patient factors were associated with on the one hand being malnourished and on the other hand being malnourished or being at risk for malnutrition.
In previous studies some factors have consistently been identified as associated of a poor nutritional status such as mouth infection [31] and cerebrovascular accident (CVA) [32]. However, no associations were found with these factors in the current study. We found also no association between gender and malnutrition.

Limitations

The present study was the largest study inventorying the malnutrition prevalence in Belgian elderly hospital wards. A large majority of all Belgian hospitals with elderly wards (81%) participated in our study. Of the 4455 eligible patients, approximately half were included in the study. Data obtained from the Federal Public Health Service

Health, Food Chain Safety and Environment showed that the characteristics of our study sample were comparable to the total sample during the study period. This gives an indication of a good representativity of the current sample.

This was a cross-sectional study meaning that data on the nutritional status and patient factors were collected at the same time. Therefore, no causal relationships can be identified. From this study, we can only conclude that malnutrition is associated with swallowing difficulties, taste difficulties, or coming from a nursing home. To identify predictive factors for malnutrition in the elderly, longitudinal studies with incidence figures are needed. A better insight into the factors that contribute to malnutrition in the elderly would enable the development of appropriate preventive and treatment strategies and improve the health of older people.

The MNA-SF and MNA data of 338 elderly (13%) were incomplete, therefore these patients were excluded from the analyses. Probably, these patients were too ill to participate . It is plausible that these elderly were at high risk for malnutrition or even malnourished. This may also result in an underestimation of the malnutrition prevalence.

The weight of some patients was estimated by the patients or by the health care worker. The specific reasons for this estimation were unclear.

Conclusion

This study learns that malnutrition is a frequently occurring problem in elderly wards in Belgian hospitals. Given the negative impact of malnutrition on mortality and morbidity, an emphasis should be placed on an effective nutritional policy in Belgian hospitals. Based on the results of this study, it can be advised to provide adequate nutritional care to elderly who have swallowing difficulties, taste difficulties, or coming

from a nursing home as these elderly are more likely to be malnourished. A systematic early identification and treatment of malnutrition are important for both patient and health care system. This strategy seems to be effective and cost-effective [33]. An general implementation of evidence based nutritional guidelines in Belgian hospitals would presumably decrease the prevalence of malnutrition.

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KV, MG, TD, BF participated in the design of the study. IB, KV carried out the study. EC, IB, KV, TD performed the statistical analysis. EC, IB, KV, MG, BF, TD helped to draft the manuscript. EC, IB, KV, MG, BF, TD read and approved the final manuscript.

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Tables

Table 1: Demographic data of excluded and included elderly

	Excluded (n=336)	Included (n=2329)	P-value	Test
	Mean (SD)	Mean (SD)		
Age (years)	84.8 (5.57)	83.8 (5.19)	0.591	T-test
Length of hospital stay (days)	21.5 (23.31)	21.7 (24.52)	0.908	T-test
	%			
Gender*			0.177	Chi-square test
Male	32.7 (109)	29.0 (664)		
Female	67.3 (224)	71.0 (1627)		
Nursing home $	20.2 (46)	15.4 (355)	0.060	Fisher's Exact
Diabetes mellitus	22.5 (76)	19.5 (455)	0.215	Fisher's Exact
Dementia	30.5 (103)	25.7 (598)	0.064	Fisher's Exact
Depression	16.0 (54)	13.1 (306)	0.172	Fisher's Exact
Delirium	9.8 (33)	10.3 (241)	0.848	Fisher's Exact
Decompensate heart failure	21.9 (74)	18.6 (433)	0.159	Fisher's Exact

* 43 missing

$ 134 missing

Table 2: Frequency of pathologies (N=2329 elderly)

Pathology	Percentage	Number
Neurological disease	37.3	1459
Dementia	15.7	598
Depression	8.0	343
Cerebrovascular accident	6.7	256
Delirium	6.3	241
Cerebral trauma	0.6	21
Other internal disease	22.4	856
Diabetes mellitus	11.9	455
Urinary infection	7.7	296
Rheumatoid arthritis	2.5	94
Nephrology	0.3	11
Respiratory disease	12	512
Chronic obstructive pulmonary disease	6.3	271
Pneumonia	5.7	241
Cardio-vascular disease	11.3	433
Decompensate heart failure	11.3	433
Surgery	10	381
Fractured neck of femur	7.7	293
Major abdominal surgery	2.3	88
Malignant disease	6.5	247
Oncology	4.9	187
Haematology	1.6	60
TOTAL	100	3817

Table 3: Characteristics of the elderly according to their nutritional status (MNA).

	Well-nourished (n=564)	At risk of malnutrition (n=997)	Malnourished (n=768)	P-value	Test
	Mean (SD)	Mean (SD)	Mean (SD)		
Age (years)	82.9 (4.91)	83.6 (5.08)	84.6 (5.41)	<0.001	ANOVA
Length of hospital stay (days)	18.7 (22.17)	21.8 (23.62)	23.7 (26.99)	<0.002	ANOVA
BMI (kg/m²)	27.4 (4.40)	25.0 (5.04)	22.2 (4.83)	<0.001	ANOVA
MNA-SF scores	12.3 (1.06)	8.7 (1.52)	5.2 (1.92)	<0.001	ANOVA
MNA- scores	-	20.1 (1.87)	12.6 (3.16)	<0.001	T-test
Gender*				0.222	Chi-square
Male	26.1 (144)	29.5 (291)	30.4 (229)		
Female	73.9 (407)	70.5 (695)	69.6 (525)		
Hospital				0.516	Chi-square
General	92.6 (522)	92.3 (920)	699 (91)		
Teaching	7.4 (42)	7.7 (77)	9.0 (69)		
Living in a nursing home $	7.0 (39)	10.9 (108)	27.5 (208)	<0.001	Chi-square

* 38 missing, $ 24 missing

Table 4: Univariate logistic binary regression with malnutrition (MNA<17) as dependent variable and patient factors as independent variables

Patient factor	% Malnutrition	(n)	OR	(95% CI)	*P*-value
Gender					
Male	34.5	(229/664)[b]	1.11	(0.91-1.34)	0.305
Female[a]	32.3	(525/1627)	1	-	-
Age (years)					
≥ 75 < 85[a]	29.6	(388/1312)	1	-	-
≥ 85	37.4	(380/1017)	1.42	(1.19-1.69)	<0.001
Source patient					<0.001<0.001
Home or service flat[a]	28.5	(430/1510)[c]	1	-	0.689
Nursing home	58.6	(208/355)	3.55	(2.80-4.51)	
Hospital	27.5	(121/440)	0.95	(0.75-1.21)	
Cerebral trauma					
Yes	38.1	(8/21)	1.25	(0.52-3.04)	0.617
No[a]	32.9	(760/2308)	1	-	-
Cerebrovascular accident					
Yes	37.5	(96/256)	1.25	(0.96-1.64)	0.103
No[a]	32.4	(672/2073)	1	-	-

Chronic hemodialysis					
Yes	54.5	(6/11)	2.45	(0.75-8.05)	0.140
No[a]	32.9	(762/2318)	1	-	-
COPD					
Yes	42.3	(102/241)	1.57	(1.19-2.05)	0.012
No[a]	31.9	(666/2088)	1	-	-
Decompensate heart failure					
Yes	37.4	(162/433)	1.27	(1.02-1.58)	0.030
No[a]	32.0	(606/1896)	1	-	-
Delirium					
Yes	49.8	(120/241)	2.20	(1.68-2.88)	<0.001
No[a]	31.0	(648/2088)	1	-	-
Dementia					
Yes	45.2	(270/598)	2.04	(1.68-2.47)	<0.001
No[a]	28.8	(498/1731)	1	-	-
Depression					
Yes	44.8	(137/306)	1.79	(1.40-2.28)	<0.001
No[a]	31.2	(631/2023)	1	-	-
Diabetes mellitus					

Yes	31.6	(144/455)	0.93	(0.75-1.16)	0.502
No[a]	33.3	(624/1874)	1	-	-
Hip fracture					
Yes	33.1	(97/293)	1.01	(0.78-1.31)	0.960
No[a]	33.0	(671/2036)	1	-	-
Liver cirrhosis					
Yes	40.0	(8/20)	1.36	(0.55-3.34)	0.504
No[a]	32.9	(760/2309)	1	-	-
Major abdominal surgery					
Yes	42.0	(37/88)	1.50	(0.97-2.31)	0.067
No[a]	32.6	(731/2241)	1	-	-
Malignant disease hematology					
Yes	33.9	(20/59)	1.04	(0.60-1.80)	0.879
No[a]	33.0	(748/2270)	1	-	-
Malignant disease oncological					
Yes	43.3	(81/187)	1.62	(1.20-2.19)	0.002
No[a]	32.1	(687/2142)	1	-	-
Pneumonia					
Yes	51.2	(111/217)	2.32	(1.75-3.07)	<0.001

No[a]	31.1	(657/2112)	1	-	-
Rheumatoid arthritis					
Yes	27.7	(26/94)	0.77	(0.49-1.22)	0.264
No[a]	33.2	(742/2235)	1	-	-
Urinary infection					
Yes	40.2	(119/296)	1.43	(1.12-1.84)	0.005
No[a]	31.9	(649/2033)	1	-	-
Chewing					
Yes	70.9	(1185/1671)[d]	1	-	
No[a]	88.2	(575/652)	4.27	(3.52-5.17)	<0.001
Digestion problem					
Yes	49.4	(194/393)	2.31	(1.86-2.89)	<0.001
No[a]	29.6	(574/1936)	1	-	-
Mouth infection					
Yes	57.4	(39/68)	2.83	(1.73-4.61)	<0.001
No[a]	32.2	(729/2261)	1	-	-
Pain					
Yes	37.5	(190/506)	1.30	(1.06-1.59)	0.014
No[a]	31.7	(578/1823)	1	-	-

Swallowing difficulty					
Yes	71.4	(200/280)	6.52	(4.94-8.60)	<0.001
No[a]	27.7	(569/2049)	1	-	-
Taste difficulty					
Yes	57.7	(71/123)	2.96	(2.04-4.28)	<0.001
No[a]	31.6	(697/2206)	1	-	-

Patient factor	Malnourished Mean (SD)	At risk or not malnourished (Mean SD)	OR	(95% CI)	*P*-value
Length of hospital stay (days)	23.7 (SD 26.99)	20.7 (SD 23.14).	1.01	1.00-1.01	0.007

OR = Odds ratio

CI = Confidence interval

COPD= Chronic obstructive pulmonary disease

SD = Standard deviation

[a] Reference category

[b] 38 missing

[c] 24 missing

[d] 6 missing

Table 5: Multivariate binary logistic regression with malnutrition (MNA<17) as dependent variable and patient factors as independent variables

	B (SE)	Wald Chi-square (χ^2)	*P*-value	OR (95% CI)
Swallowing difficulty	1.59 (0.155)	105.741	<0.001	4.92 (3.63-6.66)
Source patient[b]		60.948	<0.001	
Nursing home	1.039 (0.139)	55.948	<0.001	2.83 (2.52-3.71)
Hospital	-0.111 (0.138)	0.647	0.420	0.90 (0.68-1.17)
Taste difficulty	0.997 (0.219)	20.683	<0.001	2.71 (1.76-4.16)
Digestion problem	0.621 (0.131)	22.577	<0.001	1.86 (1.44-2.41)
Delirium	0.619 (0.160)	14.913	<0.001	1.86 (1.36-2.54)
Depression	0.573 (0.145)	15.551	<0.001	1.77 (1.33-2.36)
Major abdominal surgery	0.518 (0.219)	4.335	0.037	1.68 (1.03-2.73)
Dementia	0.530 (0.115)	21.248	<0.001	1.67 (1.36-2.13)
Pneumonia	0.512 (0.169)	9.154	0.002	1.67 (1.20-2.33)
Malignant disease (oncology)	0.486 (0.177)	7.5241	0.006	1.63 (1.15-2.30)
COPD	0.350 (0.162)	4.674	0.031	1.42 (1.03-1.95)
Age ≥ 85 years[a]	0.294 (0.102)	8.283	0.004	1.34 (1.10-1.64)
Hospital stay	0.005(0.002)	6.843	0.009	1.01 (1.00-1.01)
Mouth infection	0.296 (0.304)	0.948	0.330	1.34 (0.74-2.44)

Pain	0.174 (0.124)	1.984	0.159	1.19 (0.93-1.52)
Urinary infection	0.103 (0.149)	0.476	0.490	1.11 (0.83-1.48)
Decompensate heart failure	0.022 (0.130)	0.028	0.867	1.02 (0.79-1.32)

B = Regression coefficient

SE = Standard error

OR = Odds ratio,

CI = Confidence interval

COPD = Chronic obstructive pulmonary disease

[a] Reference category is ≥ 75 <85 years

[b] Reference category is home or service flat